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T55-L-712 Turbine Engine Compressor Housing Refurbishment Project

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T55-L-712 TURBINE ENGINE COMPRESSOR HOUSING REFURBISHMENT PROJECT

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SUMMARY

A study was conducted to assess the feasibility of reclaiming T55-L-712 turbine engine compressor housings with an 88 wt % aluminum - 12 wt % silicon alloy applied by the plasma spray processes. Tensile strength testing was conducted on as-sprayed and thermally cycled test specimens which were plasma sprayed from 0.020 to 0.100 in. Satisfactory tensile strength valves were observed in the as-sprayed tensile specimens. There was essentially no decrease in tensile strength after thermally cycling the tensile specimens.

E-3571

INTRODUCTION

Currently, there are seven-hundred turbine engine compressor housings at the Corpus Christi Army Depot which are out of tolerance due to corrosive pitting and nonconformance to dimensional specifications. They cannot be reclaimed without additions of material. The materials needed to effect repairs to the housing has to meet the following requirements:

(1) The thermal expansion coefficient had to be similar to Alloy number HZ32A (AMS 4447) which is the magnesium alloy of construction of the case.

(2) Ability to withstand 370 °C in air for long durations.

(3) Must have good bond characteristics to ASM 4447 and be capable of being applied up to 0.100 thousandths of an inch.

(4) This material will be used to bring all out of tolerance surfaces back to original dimensions; i.e., pilot diameters, end to end face surface dimensions, etc.

It is recommended that the plasma spray processes be used to add material to the turbine compressor housings so that they may be reclaimed.

The author has established a minimum tensile strength requirement of 3000 psi for this program which are representative of a high integrity plasma sprayed aluminum-silicon coating system.

PROCEDURE

Plasma Spray Process

The plasma spray process was chosen because the resulting coating systems have high interparticle cohesion and have excellent adhesion to a variety of materials.

Material Composition

The material chosen to reclaim the AVCO Lycoming T55-L-712 compressor housings is an 88Al-12Si(wt %) alloy, Metco 52CNS. The percentages of Aluminum and Silicon are expressed in weight percent. This material meets all of the requirements outlined above. It also meets AVCO Lycomings specification number M3962A. It was necessary to use a bond coat to provide a rough surface for higher bond strength characteristics. The bond coat is a 95Ni-5Al (wt %) alloy, Metco 450NS, which meets AVCO Lycomings specification number M3951.

Thermal expansion coefficient. - The 88Al-12Si alloy is similar in composition to aluminum alloy number 4032, which has a 12.5 wt % silicon addition. The thermal expansion coefficient for the number 4032 alloy is 20.3 μin./in./°C (ref. 1) at +20 to +200 °C.

The above figures indicate that the 88Al-12Si alloy is a close match in thermal expansion for this application to the HZ32A magnesium alloy which has a thermal expansion coefficient of 26.7 μin./in./°C at 20 to 200 °C (ref. 2).

Plasma Spray Procedure

The plasma spray procedure detailed in Attachment 1 describes the requirements and preparations necessary to reclaim the compressor housings. The procedure is basically unchanged except for the deletion of the Metcoseal "M" sealer and the insertion of the Metcoseal "SA" sealer. The manufacturer of Metcoseal "M", Metco Incorporated, has done testing which shows that the sealer dissolves in 1 hr when exposed to type JP4 jet fuel or type MIL-L-23699 synthetic turbine oil. Metco has recommended that another sealer, Metcoseal "SA" which is in the same exposure test as Metcoseal "M" has shown no sign of degradation.

Evaluations

Tensile testing. - The tensile tests were done according to ASTM C-633-79 titled Standard Test Method for Adhesion of Cohesive Strength of Flame Sprayed Coatings. Fifty ASM 4447, specimens with varying diameters were coated by plasma spraying with 0.005 in.±0.001 in. of 95Ni-5Al composite powder and were overcoated with the 88Al-12Si alloy. Coating thicknesses of the 88Al-12Si alloy were varied as follows:

(1) Ten specimens at 0.020 in.±0.001 in.
(2) Ten specimens at 0.040 in.±0.001 in.
(3) Ten specimens at 0.060 in.±0.001 in.
(4) Ten specimens at 0.080 in.±0.001 in.
(5) Ten specimens at 0.100 in.±0.001 in.

The surface area of the magnesium plasma sprayed specimens was calculated from the equation:

$$\frac{\pi}{4 * D^2}$$

Thermal cycling. - This test was utilized to evaluate the effect of thermal exposure on the plasma sprayed coating system applied to magnesium compressor housing samples. Five individual test conditions were used to evaluate each set of samples. Each set of samples consist of five samples, at the following coating thicknesses: 0.020, 0.040, 0.060, 0.080, 0.100 in. A type "R" thermocouple was used to verify sample temperatures were attained during testing. However, the specimens in group one were not thermocoupled during the liquid nitrogen quench. It was assumed that when the boiling of liquid nitrogen subsided, the magnesium specimens were at the temperature of liquid nitrogen. The following test conditions were applied to the specimens;

Test Condition number 1: The specimens were heated in a rapid temperature furnace to 370 °C and then quenched in liquid nitrogen. This process was repeated approximately 15 times.

Test Condition number 2: Each specimen was heated from ambient conditions to 370 °C and forced air quenched back to ambient conditions. This process was repeated approximately 15 times.

Test Condition number 3: Each specimen was heated to 120 °C. Then the furnace was ramped to 300 °C after which the specimens were allowed to cool to 120 °C. This process was repeated approximately 15 times.

Test Condition number 4: Each specimen was heated to 120 °C. Then the furnace was ramped to 300 °C but the specimens were held at this temperature for 6 hr to simulate a flight duration. This process was not repeated.

Test Condition number 5: The specimens were placed in the furnace and the temperature was ramped from ambient conditions to 370 °C and the specimens were left at his temperature for 12 hr. This process was not repeated.

Metallography. - The following metallography procedure was established by Metco Inc. and was provided for this program. All polishing was done by hand.

(1) Wet grind sample on silicon carbide papers (discs), Grits 180, 240, 320, 400, and 600 respectively, using water as coolant. Each paper is used to remove the coarse scratches from the previous grit paper. (Sample should be held so that grinding is perpendicular to the coating, and coating is in compression against the substrate).

(2) Polish sample on a silk cloth (A. Buehler number 40-7408), that is lightly charged with a 6 μm diamond compound. Polish out the 600 grit scratches by holding the sample 90 ° to the previous scratches. Wheel speed should be approximately 550 rpm.

(3) Polish sample next on a 3 μm diamond charged silk cloth to remove the 6 μm scratches. Use a slight amount of lapping oil (similar to A. Buehler number 60-3250), to keep cloths slight damp in steps 2 and 3.

(4) Fine polish next on a felt type cloth, (A. Buehler microcloth number 40-7208), impregnated with a 1 μm diamond compound. Keep cloth relatively moist with an alcohol based extender. Remove 3 μm scratches by alternating direction of polishing every 5 to 7 sec which the wheel is turning at a slow speed of approximately 175 rpm. Do not rotate sample on the cloth. A fresh application of diamond may have to be applied for each sample.

(5) Final polish sample on A. Buehler Selvyt cloth number 40-7008, (or similar cloth), that is charged with 1/2 μm diamond compound. A slow wheel speed should be used while applying an alcohol based diamond extender to the cloth while polishing out fine 1 μm scratches. Note: A water based diamond extender, such as (Buehler metadi fluid number 40-6016), may be preferable to use instead of an alcohol base extender to prevent anodic etching of magnesium substrate material.

Results

Tensile test results. - The results of the tensile test on the as-sprayed 88Al-12Si alloy showed that all failures were observed to be cohesive/adhesive at the bond coat, top coat interface (ref. 3). The reason that the failure was termed cohesive/adhesive was that the 88Al-12Si coating fractured away from the bond coat leaving some residual coating behind in almost every case.

The equation used to find the actual tensile strength is as follows:

$$UTS = \frac{L}{A}$$

where

UTS = cohesive or adhesive strength-force per unit of surface area
L = load to failure-force
A = cross-sectional area of the specimen

The actual tensile strength for each as-sprayed specimen is as follows:

Group number 1

Sample 1-1: UTS(0.020 in.) = 4968 psi
Sample 1-2: UTS(0.020 in.) = 4854 psi
Sample 1-3: UTS(0.020 in.) = 4268 psi
Sample 1-4: UTS(0.020 in.) = 3919 psi
Sample 1-5: UTS(0.020 in.) = 3461 psi

Group number 2

Sample 2-1: UTS(0.040 in.) = 4573 psi
Sample 2-2: UTS(0.040 in.) = 5013 psi
Sample 2-3: UTS(0.040 in.) = 5273 psi
Sample 2-4: UTS(0.040 in.) = 3753 psi
Sample 2-5: UTS(0.040 in.) = 3461 psi

Group number 3

Sample 3-1: UTS(0.060 in.) = 5045 psi
Sample 3-2: UTS(0.060 in.) = 4778 psi
Sample 3-3: UTS(0.060 in.) = 4020 psi
Sample 3-4: UTS(0.060 in.) = 5032 psi
Sample 3-5: UTS(0.060 in.) = 4796 psi

Group number 4

Sample 4-3: UTS(0.080 in.) = 3685 psi
Sample 4-4: UTS(0.080 in.) = 3651 psi
Sample 4-5: UTS(0.080 in.) = 3822 psi

Group number 5

Sample 5-1: UTS(0.100 in.) = 4841 psi
Sample 5-2: UTS(0.100 in.) = 5108 psi
Sample 5-3: UTS(0.100 in.) = 4453 psi
Sample 5-4: UTS(0.100 in.) = 4822 psi
Sample 5-5: UTS(0.100 in.) = 4682 psi

The average tensile strengths and standard deviations for the as-sprayed coating system are as follows:

Sample set number 1: UTS(0.020 in.) = 4294 psi S = 633
Sample set number 2: UTS(0.040 in.) = 4653 psi S = 666
Sample set number 3: UTS(0.060 in.) = 4734 psi S = 419
Sample set number 4: UTS(0.080 in.) = 3719 psi S = 91
Sample set number 5: UTS(0.100 in.) = 4781 psi S = 240

An overall common standard deviation calculated from the standard deviations squared is 466 psi.

Epoxy specimens were run at the same time that all of the other specimens were prepared. Approximately five specimens were prepared. Stainless steel, 1 in. diameter by 2 in. length slugs were grit blasted with 20 grit alumina media and epoxied together. The average tensile strength of the epoxy was 6899 psi.

Thermal Cycling

Each test condition had one specimen of each coating thickness, from 0.020 in. to 0.100 in., which was a total of five specimens per condition. Again, all of the specimens were observed to have failed in the cohesive/adhesive mode at the bond coat, top coat interface. The same equation used in the as-sprayed tensile test is applicable here. The actual tensile strength for each specimen is as follows:

Test Condition number 1

Sample 1-6: UTS(0.020 in.) = 5483 psi
Sample 2-6: UTS(0.040 in.) = 4127 psi
Sample 3-6: UTS(0.060 in.) = 4408 psi
Sample 4-6: UTS(0.080 in.) = 3694 psi
Sample 5-6: UTS(0.100 in.) = 4453 psi

Test Condition number 2

Sample 1-7: UTS(0.020 in.) = 5376 psi
Sample 2-7: UTS(0.040 in.) = 4701 psi
Sample 3-7: UTS(0.060 in.) = 3248 psi
Sample 4-7: UTS(0.080 in.) = 3962 psi
Sample 5-7: UTS(0.100 in.) = 4127 psi

Test Condition number 3

Sample 1-8: UTS(0.020 in.) = 5318 psi
Sample 2-8: UTS(0.040 in.) = 4612 psi
Sample 3-8: UTS(0.060 in.) = 3975 psi
Sample 4-8: UTS(0.080 in.) = 3758 psi
Sample 5-8: UTS(0.100 in.) = 4275 psi

Test Condition number 4

Sample 1-9: UTS(0.020 in.) = 5592 psi
Sample 2-9: UTS(0.040 in.) = 2790 psi
Sample 3-9: UTS(0.060 in.) = 4542 psi
Sample 4-9: UTS(0.080 in.) = 4153 psi
Sample 5-9: UTS(0.100 in.) = 4382 psi

Test Condition number 5

Sample 1-10: UTS(0.020 in.) = 4198 psi
Sample 2-10: UTS(0.040 in.) = 4204 psi
Sample 3-10: UTS(0.060 in.) = 3753 psi
Sample 4-10: UTS(0.080 in.) = 4153 psi
Sample 5-10: UTS(0.100 in.) = 4206 psi

All of the specimens which were thermally cycled showed no evidence of delamination or spallation after cycling, before tensile testing.

Metallography

The attached photomicrographs are representative of Metco Inc. standard argon/hydrogen and nitrogen/hydrogen parameter sets number 3 and 4 for both the 88Al-12Si alloy and the 95Ni-5Al composite powder (see fig. 2). Also included are the photomicrographs of the metallography specimens sprayed along with the tensile specimens (see fig. 3).

CONCLUSIONS

The tensile strength of the plasma sprayed 88Al-12Si alloy, did not seem to be affected by the thermal cycling test. The tensile strength is comparable to the as-sprayed 88Al-12Si alloy. However, there is a slight decrease in tensile strength from thermal cycling when the coating thickness was increased from 0.020 to 0.100 in. Worst case reclaimation of the T55-L-712 compressor housings is considered to be 0.100 in. The tensile strength data shows that this coating system is feasible for even worst case reclaimation.

It is further recommended that a quality control baseline be implemented by the Corpus Christi Army Depot, i.e., plasma spraying of metallography samples each time compressor housings are processed, and that tensile test specimens are also sprayed to perform tensile tests at random intervals when the compressor housings are being processed. It is also very important to treat each variable of the plasma spray process as critical when plasma spraying, i.e.; maintaining kilowatts, spray distance, etc., to maintain coating reproducibility and integrity.

APPENDIX - T55-L-712 COMPRESSOR HOUSING REFURBISHMENT PROCEDURE

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INTRODUCTION;

These procedures describe the requirements and preparations for reclaiming compressor housings utilizing a Plasma Spray Process.

REFERENCE DOCUMENT;

The following procedure has been structured from the Depot Maintenance Work Requirements (DMWR NO. 55-2840-254)) dated 28 September 1984 and a specified Plasma Spray Procedure from George W. Leissler, Engineering Associate V., Sverdrup Technology Incorporated.

NOTE:

Due to possible variations in the DMWR procedures versus actual modified procedures used by depot personnel, revisions to this procedure to interface with current work requirements are permitted. These revised steps must be documented and approved by the appropriate authority.

COMPRESSOR HOUSING REFURBISHMENT PROCEDURE

INTRODUCTION

To begin this process reference section XIV of DMWR 55-2840-254, page 5-774.

_____ Perform disassembly of Compressor Housing and Vane Assembly as described in paragraph 5-414 and complete steps a. through m.

_____ Perform cleaning of Compressor Housing and Vane Assembly as described in paragraph 5-415.

_____ Perform inspection of Compressor Housing and Vane Assembly as described in paragraph 5-416.

5-417. REPAIR OF COMPRESSOR HOUSING AND VANE ASSEMBLY.

_____ Replace step e. with the following procedure.

5-417. (cont.)

e. Housing assembly (compressor) (99, figure 5-311).

_____ (1). Perform removal of Engine Gray Enamel using steps g. Method B. items (1a),(1b), or (1c). (Reference SP No. 6022 in appendix D).

_____ (2). Vapor degrease compressor housing using Triclorethane (item 252 in appendix C or equal).

_____ (3). Ensure removal of all residue from the compressor housing using clean dry air.

_____ (4). Perform step e. items (1),(3a), and (3b) in DMWR 55-2840-254.

_____ (5). Perform step e. items (4a) and (4b) in DMWR 55-2840-254.

_____ (6). Perform step e. items (6a through 6f) in DMWR 55-2840-254.

_____ (7). Perform step e. item (7a) and (7b) in DMWR 55-2840-254.

REFERENCE ITEM (8) IN DMWR 55-2840-254 AND REPLACE OR INSERT THE FOLLOWING STEPS AS INDICATED.

(8). Repair compressor housing to restore dimensions by plasma spray method as follows:

PREMACHINING:

____ (a). Place housing assemblies (99, figure 5-311) in a suitable locating fixture and center on a vertical turret lathe or equivalent.

____ (b). Position contour gage template assembly LTCT11420 or equivalent, in trace section of vertical turret lathe.

____ (c). Bring cutting tool into contact with housing assembly at location A (see figure 5-319) and bring tracer stylus into contact with template at corresponding location.

____ (d). Raise tracer, as necessary, to machine contour to obtain a .010 inch minimum plasma spray buildup thickness after final machining and painting. Up to .___ inch maximum thickness is permissible. Check contour with gage LTCT11421 or equivalent. Cleanup as required from location A to O, figure 5-319.

(e). The following areas of the compressor housing requiring restoration must be machined to obtain a.010 minimum plasma spray buildup thickness after final machining and painting. (reference figure 5-318 for final dimensional specifications and locations.

____ 1. Compressor housing I.D. in vane assembly and insert mounting area.

____ 2. Compressor housing pilot diameters A,B,C.D. and K.

____ 3. Compressor housing end to end face surface dimensions (refer to 12.512/12.502 dimension in figure 5-318).

____ (f). Clean housing assembly by vapor degreasing method (reference SP No. 3000 in appendix D).

GRIT BLASTING:

CAUTION:

GRIT BLASTING PRESSURE MUST BE PRE-DETERMINED BEFORE CONTINUING AS FOLLOWS:

____ * Use a compressor housing test sample to determine pressure level setting.

____ * Set the pressure at a suitable level which does not permit grit entrapment into the base material. A 10 power microscope shall be required to inspect the compressor housing surfaces for grit entrapment. If entrapment occurs, lower pressure level and repeat this procedure until a satisfactory pressure has been reached.

____ (a). Set grit blasting machine pressure at __ psi.

____ (b). Grit blast areas requiring material addition with angular steel grit. (reference item 5 of attachment A)

____ (c). Remove all residual grit and foreign particles from compressor housing using clean dry air.

MASKING:

NOTE:

ALL AREAS OF THE COMPRESSOR HOUSING NOT REQUIRING MATERIAL ADDITION ARE TO BE MASKED TO PREVENT HOT PARTICLES FROM THE PLASMA SPRAY PROCESS FROM BONDING IN THESE AREAS.

ANTI-BOND IS WATER SOLUABLE. DURING STORAGE SEGRAGATION OF THIS COMPOUND IS COMMON. IF THIS OCCURS RESTORE CONSISTENCY AS REQUIRED BY STIRRING IN SMALL QUANTITIES OF WATER.

____ (a). Apply one coat of anti-bond (reference item 1 of attachment A) to all smooth surfaces. (refer to procedure (b).,1* below)

____ (b). Apply two coats of anti-bond (reference item 1 of attachment A) to grit blasted areas not requiring plasma spraying as follows:

1*. Application of the anti-bond can be accomplished by two methods, brush on or spray on.

*a. BRUSH ON: Prepare anti-bond as follows:

* Mix anti-bond thoroughly adding water to thin if necessary until the mixture will give a consistency similar to "No Drip Latex Paint". Check consistency by dipping a 1/2 inch dowel into the anti-bond and observe mixture runoff. Runoff should be 2-10 drops a minute.

CAUTION:

DURING APPLICATION OF THE ANTI-BOND COMPOUND, IF THE MIXTURE RUNS, THICKEN MIXTURE BY THE ADDITION OF ANTI-BOND AND STIR THOROUGHLY.

1. Apply with paint brush using suitable care to provide an uniform coating.

*b. SPRAY ON: Prepare anti-bond as follows:

* Mix anti-bond thoroughly adding water to thin if necessary until the mixture will give a consistency similar to "No Drip Latex Paint". Check consistency by dipping a 1/2 inch dowel into the anti-bond and observe mixture runoff. Runoff should be 2-10 drops a minute.

1. Use spray gun Binks No. 29 (suction type) or equivalent with nozzle 66 x 66 S.D. or equal to apply anti-bond.

2. Using 40 to 50 psi compressed dry air, hold spray gun 8 to 12 inches from surface, and make passes at a linear rate of 6 inches per second to apply a uniform coat of anti-bond.

CAUTION:

EACH COAT OF THE ANTI-BOND MUST DRY THOROUGHLY BEFORE APPLICATION OF THE SECOND COAT. THE ANTI-BOND WILL DRY AT ROOM TEMPERATURE (78 deg. F) IN APPROXIMATELY (15) MINUTES. THE ANTI-BOND WHEN DRY WILL BE BLUE-BLACK IN COLOR.

NOTE:

IF THE ANTI-BOND IS OVERHEATED DURING PLASMA SPRAYING IT WILL TURN BROWNISH IN COLOR. THIS IS AN INDICATION OF BASE MATERIAL OVERHEATING.

PLASMA SPRAYING:

CAUTION:

IT IS RECOMMENDED THAT PLASMA SPRAYING BE DONE IMMEDIATELY AFTER SURFACE PREPARATION. IF THIS IS NOT POSSIBLE, TREAT ALL EXPOSED SURFACES WITH SOLUTION (item 226 in appendix C) TO PREVENT OXIDATION OF THE MAGNESIUM HOUSINGS. THIS SOLUTION MUST BE REMOVED ON SURFACES THAT REQUIRE MATERIAL ADDITION BEFORE PLASMA SPRAYING. (refer to grit blasting section of this procedure).

EACH PROCESS VARIABLE OF THE PLASMA SPRAY PARAMETERS MUST BE RIGIDILY CONTROLLED SO THAT THE COATING INTEGRITY AND REPRODUCIBILITY CAN BE MAINTAINED.

_____ (a). Place compressor housing (99, figure 5-311) in a suitable fixture in plasma spray area.

_____ (b). Position plasma spray gun (type 7MB/9MB), with nozzle (GH/732), powder port (#1), and insulator (7M50/9M50) perpendicular to the housing surface.

_____ (c). Set the spray distance from the gun to surface at 5 inches ± 1 inch.

NOTE:

POWER SETTINGS FOR THE P 52C-10 COATING SYSTEM ARE AS FOLLOWS:

* Arc amps. - 500 ± 10

* Arc volts - 67 ± 3

* Kilowatt output - 33.5 ± 1.5 KW

_____ (d). Set the following parameters for material addition utilizing coating system P 52C-10, set #4.

1. Set the primary gas pressure and flow, with the exhaust system on, as follows:

_____ a. Set the primary gas pressure at 100 psi. (ARGON GAS)

_____ b. Set the secondary gas pressure at 50 psi. (HYDROGEN GAS)

_____ c. Set the primary flow at 80.

EXTREME CAUTION:

THE SECONDARY GAS FLOW VALVE MUST REMAIN CLOSED UNTIL THE HIGH FREQUENCY IGNITION OCCURS AND THE PLASMA SPRAY GUN IS AT FULL OPERATION. FAILURE TO FOLLOW THIS PROCESS WILL RESULT IN GUN FAILURE OR EXPLOSION.

_____ d. Slowly introduce secondary gas flow while maintaining machine amperage, and set at 15.

_____ 2. Set the carrier gas flow at 37

_____ 3. Set the spray rate at 10 pounds per hour ± 1 pound per hour.

a. Set the powder feed (3 MP DUAL) for the spray gun as follows:

_____ *. Ensure the carrier gas flow has been set

_____ *. Weigh a clean dry container sufficient to hold 5 lbs. of Metco 52 C powder item 4 on attachment A.

_____ *. Allow the powder feed to stabilize after startup (approx. 1 to 3 minutes), then feed the powder into the container for (1) minmute.

_____ *. Reweigh the container with the contents.

_____ *. The result of the container weight with powder minus the empty container weight is equal to grams per minute spray rate. To obtain lbs/hr. spray rate multiply grams per minute by .11328.

_____ 4. Install the "H" metering wheel.

_____ (e). Plasma spray areas requiring material addition until the coating is .015 to .020 inches oversized from the desired final dimensions.

1. To ensure a uniform coating of plasma spray addition, move gun at a linear rate of 75 feet per minute.

CAUTION:

DURING PLASMA SPRAYING OF THE COMPRESSOR HOUSING, IT IS REQUIRED THAT THE BASE MATERIAL TEMPERATURE BE KEPT UNDER 300 DEG. F

NOTE:

OVERHEATING OF THE BASE MATERIAL CAN BE IDENTIFIED BY DISCOLORATION OF THE ANTI-BOND ADJACENT TO THE SURFACE BEING SPRAYED. (Refer to NOTE: in Masking section of this procedure).

INSTRUMENTAION OF THE COMPRESSOR HOUSING BASE MATERIAL CAN BE DONE WITH A THERMAL SENSING DEVICE MOUNTED ON THE OPPOSITE SIDE OF THE SURFACE BEING SPRAYED. THIS WILL PROVIDE AN ACCURATE TEMPERATURE MEASUREMENT.

_____ 2. If base material overheating occurs, adjust traverse speed accordingly to lower base material temperature. Do not exceed 115 feet/minute.

3. Perform the following sequence to shutdown the plasma spray machine:

_____ a. Depress console powder feed off button.

_____ b. Keeping amperage constant, close the secondary gas flow valve.

_____ c. Reduce amperage to "0".

_____ d. Depress run button on control panel.

_____ e. Purge primary gas through the plasma gun for 1 to 2 minutes to keep the electrode from oxidizing while cooling.

ANTI-BOND REMOVAL:

_____ (a). Remove anti-bond with warm water.

_____ 1. Heavy overspray from material addition may require light wire brushing.

CAUTION:

DO NOT USE SOLVENTS OR DEGREASING AGENTS TO REMOVE ANTI-BOND.

_____ (b). Permit compressor housing to dry before post machining.

_____ 1. Drying can be accelerated by use of clean dry air blast.

POST MACHINING:

CAUTION:

DURING FINAL MACHINING ENSURE THAT THE COATING HAS NOT SEPERATED FROM THE BASE MATERIAL.(PULLOUT) IF PULLOUT IS EVIDENT ENSURE THAT THE MACHINING PARAMETERS USED, (ie. dull tool bits, excessive material removal, etc...) WERE NOT AT FAULT.

(a). Final machine compressor housing areas that have been plasma sprayed to dimensions shown in DMWR (reference figure 5-318) as listed:

____ 1. Machine centrifugal land area using location A and location O (figure 5-319) as contour gage points. Final check with contour gage or equivalent.

____ 2. Compressor housing I.D. in vane assembly and insert mounting area.

____ 3. Compressor housing pilot diameters A,B,C,D, AND K.

____ 4. Compressor housing end to end face surface.

CAUTION:

FINAL MACHINED DIMENSIONS MUST INCLUDE A .002 TO .004 TOLERANCE FOR APPLICATION OF METCOSEAL "M" SEALER.

SEALER:

(A). Prepare sealer item 2 on attachment A as follows:

____ 1. Mix sealer with thinner (mineral spirits) to give a __ to __ second viscosity at 80 deg.F using zahn cup # _.

NOTE:

IF COATING APPLICATION MUST BE THICKER, A HIGHER VISCOSITY FORMULA MAY BE USED

____ (b). Ensure compressor housing is clean and dry before application of the sealer.

(c). Apply sealer to compressor housing using the following equipment and settings:

____ 1. Spray gun Binks No 29 (suction type) or equal, with nozzle 66 x 66 S.D. or equal.

NOTE:

USING 40 TO 60 PSI. COMPRESSED DRY AIR, HOLD GUN APPROXIMATELY 12 INCHES FROM SURFACE AND MAKE LINEAR PASSES AT 6 INCHES PER SECOND TO APPLY A UNIFORM COATING.

_____ 2. Apply sufficient sealer to obtain a .002 to .004 coating on the compressor housing.

NOTE:

THICKNESS OF COATING MAY BE DETERMINED BY MICROMETER MEASUREMENT OF PART

SPRAYED COATING SHALL BE SMOOTH AND FIRMLY ADHERED TO BASE MATERIAL. NO EVIDENCE OF BLISTERING OF SEALER COAT IS PERMITTED

_____ 3. Permit sealer coating to room cure for a minimum of 15 hours before beginning reassembly.

CONTINUE PROCESS OF COMPRESSOR HOUSING AND VANE ASSEMBLY REASSEMBLY PER PARAGRAPH 5-418 IN DMWR 55-2840-254.

ATTACHMENT "A"

MATERIALS LIST

ITEM NO.	DISCRIPTION
1.	ANTI-BOND, METCO PRODUCTS NO. 12088
2.	SEALER, METCO "M", PRODUCTS NO. 01381
3.	THINNER, MINERAL SPIRITS (AVAILIBLE AT CCAD)
4.	PLASMA SPRAY POWDER, METCO "52C", PRODUCT NO. 12108
5.	GRIT, STEEL, ANGULAR CHILLED, METCO PRODUCTS NO. 27134

SOURCE:

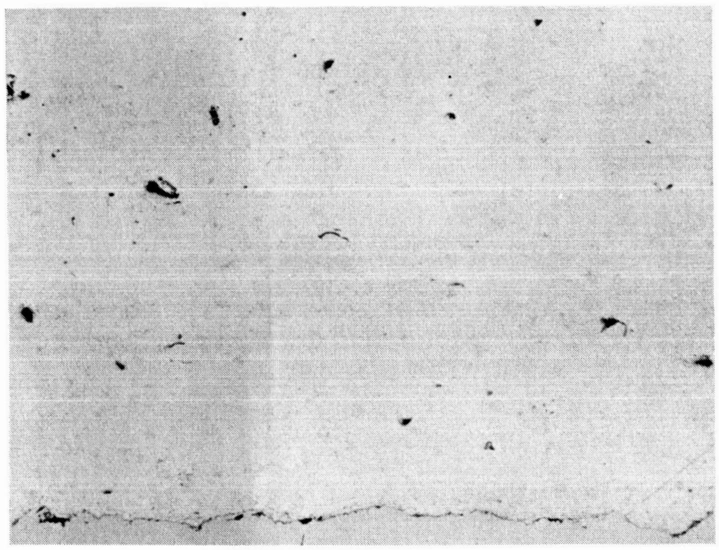
METCO
1101 PROSPECT ROAD
WESTBURY, NEW YORK 11590
PHONE: (516) 334-1300

REFERENCES

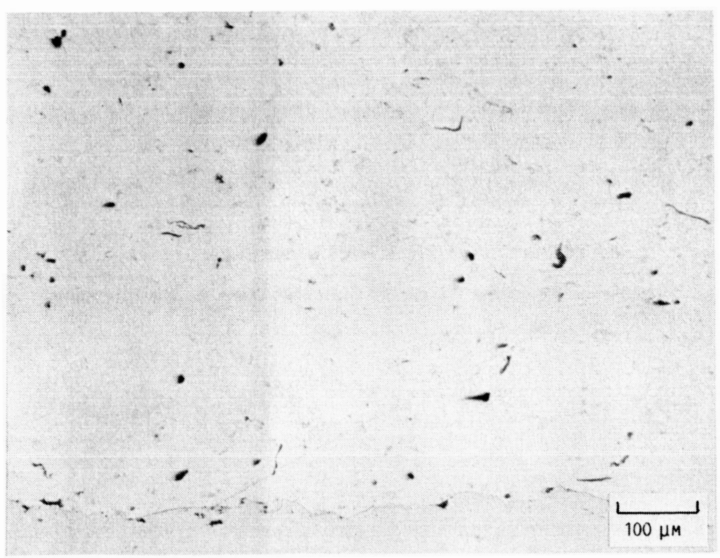
1. Metals Handbook, Vol. 1, "Properties and Selection of Metals, 8th ed., American Society of Metals, 1961, p. 942.

2. Metals Handbook, Vol. 1, "Properties and Selection of Metals, 8th ed., American Society of Metals, 1961, p. 1101.

3. Thermal Spraying: Practice, Theory and Application, American Welding Society, 1985, Chapter 6.5.



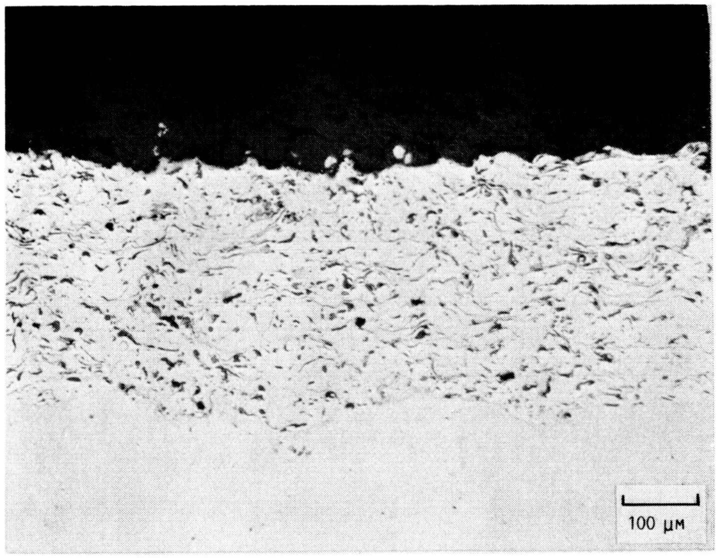
(A) PARAMETER SET NO.3 AR/H_2.



(B) PARAMETER SET NO.4 N_2/H_2.

FIGURE 1. - STANDARD PHOTOMICROGRAPH OF 52C-NS (88Al-12Si ALLOY).

(C) PARAMETER SET NO.3 AR/H_2.



(D) PARAMETER SET NO.4 N^2/H_2.

FIGURE 1. - CONCLUDED. STANDARD PHOTOMICROGRAPH OF 450-NS (95Ni -5Al COMPOSITE).

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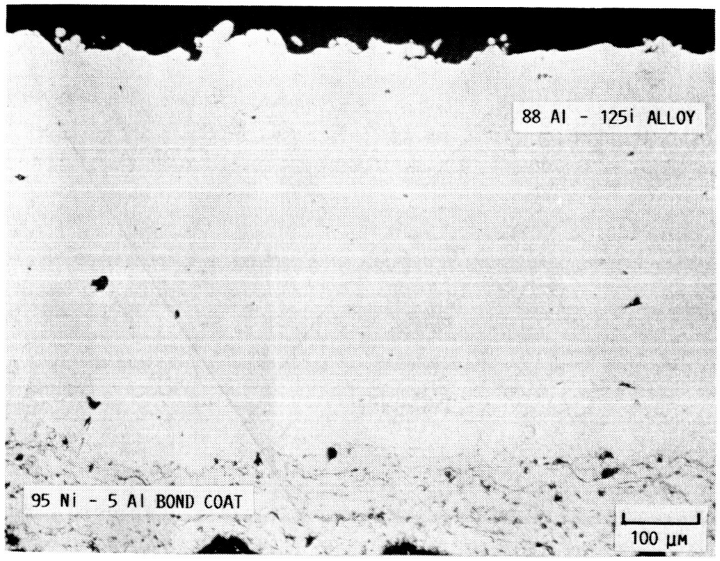

PARAMETER SET NO.3 ARGON/HYDROGEN

FIGURE 2. - METALLOGRAPHY SPECIMEN REPRESENTATIVE OF THE TENSILE SPECIMENS SPRAYED AT THE CORPUS CHRISTI ARMY DEPOT, CORPUS CHRISTI, TEXAS.

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		6. Performing Organization Code
7. Author(s) George W. Leissler		8. Performing Organization Report No. None (E-3571)
		10. Work Unit No. 1L161102AH45 505-63-01
9. Performing Organization Name and Address Propulsion Directorate, U.S. Army Aviation Research and Technology Activity—AVSCOM; Lewis Research Center, Cleveland, Ohio 44135; Sverdrup Technology, Inc., Lewis Research Center, Cleveland, Ohio 44135; and NASA Lewis Research Center, Cleveland, Ohio 44135		11. Contract or Grant No. NAS3-24105
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Project Manager, John S. Yuhas, Research Support Division, Propulsion Directorate, U.S. Army Aviation Research and Technology Activity—AVSCOM. Appendix—T55-L-712 Compressor Housing Refurbishment Procedure by Carl Reitenbach, Research Support Division, Propulsion Directorate, U.S. Army Aviation Research and Technology Activity—AVSCOM. George W. Leissler, Sverdrup Technology, Inc.

16. Abstract

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